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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/784,821	02/24/2004	Yoshihisa Iba	042139	8491

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EXAMINER

LEE, CHEUNG

ART UNIT PAPER NUMBER

2812

DATE MAILED: 05/16/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/784,821

Applicant(s)

IBA, YOSHIHISA

Examiner

Cheung Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 14 April 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 2-13 and 17-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 2-13 and 17-25 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
- 1) ☒ Certified copies of the priority documents have been received.
  - 2) ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - 3) ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>1-25-06</u> | 6) <input type="checkbox"/> Other: _____  |

**DETAILED ACTION**

***Notice to Applicant***

1. Applicants' Request of Continued Examination (RCE) filed on April 14, 2006 has been entered and made of record.

***Response to Amendment***

2. In view of applicant's amendment to the claim, the objection to claims 14-16 has been withdrawn.

3. In view of applicant's amendments and arguments filed on March 14, 2006, the rejections of claims 2-13 and 17-25 under 35 U.S.C. 103(a) as stated in the indicated Office Action have been withdrawn. Applicant's arguments have been rendered moot in view of the new or modified ground of rejection given below.

***Specification***

4. The incorporation of essential material in the specification by reference to an unpublished U.S. application, foreign application or patent, or to a publication is improper. Applicant is required to amend the disclosure to include the material incorporated by reference, if the material is relied upon to overcome any objection, rejection, or other requirement imposed by the Office. The amendment must be accompanied by a statement executed by the applicant, or a practitioner representing the applicant, stating that the material being inserted is the material previously

incorporated by reference and that the amendment contains no new matter. 37 CFR 1.57(f).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 2-3, 5, 8-9, 12, 17, 19-20, 22-23 and 25 are rejected under 35 U.S.C.

103(a) as being unpatentable over Applicant's admitted prior art (hereinafter "APA") in view of Yamanaka et al. (US Pub. 2003/0186537; hereinafter "Yamanaka").

6. Referring to figures 8A-8D and related text, APA discloses [Re claims 2 and 8] a method of fabricating a semiconductor device, comprising the step of: forming an SiC barrier film 103 over an interconnection 102; forming an interlayer dielectric film containing Si, C, and O 104-105 over the SiC barrier film, the examiner interpreted that at least at the interfaces of layer 105 with silica and SiO<sub>2</sub>, layers of Si, C, O are formed, wherein the interlayer dielectric is a low dielectric film (paragraph 11); forming a hole reaching the SiC barrier film in the interlayer dielectric film (see fig. 8C); etching the SiC barrier film to allow the hole to reach the interconnection (see fig. 8D); and burying a conductive material in the hole (paragraphs 9-10). But, it fails to disclose expressly performing plasma processing using a hydrogen-containing gas on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole, thereby forming an /

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organic film on the side surfaces of the interlayer dielectric film with the interconnection being covered with the SiC barrier film; etching the SiC barrier film after the plasma processing; [Re claim 3] wherein a gas containing at least H<sub>2</sub> gas is used as the hydrogen-containing gas; [Re claim 5] wherein the side surfaces of the interlayer dielectric film is modified by the plasma processing, thereby increasing a selectivity to the SiC barrier film; [Re claim 9] wherein the plasma processing is performed by supplying a gas containing carbon and fluorine into a processing chamber.

Referring to figures 7A-7H, Yamanaka discloses a plasma 17 treatment composed of H<sub>2</sub> gas with an interconnection 3 being covered (see fig. 7C; page 10, paragraph 144). Especially, the wall portion of a via hole 8 are impacted by the plasma processing (page 10, paragraph 144). Yamanaka also discloses wherein an etching is performed with respect to the portion of a protective film 4 exposed in the via hole after the plasma treatment (see fig. 7G). Also, referring to figures 4A-4E, Yamanaka discloses a plasma treatment 13 with fluorocarbon gas such as C<sub>4</sub>F<sub>8</sub>, and a fluorocarbon film 14 formed by the plasma treatment (pages 6-7, paragraphs 94 and 104).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the plasma treatment, as taught by Yamanaka.

The motivation for doing so would have been to neutralize or to reduce the amine or the basic material in the low dielectric constant film, and to prevent the resist poisoning phenomenon (page 3, paragraphs 31 and 37).

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7. [Re claim 12] The combined teaching of APA and Yamanaka discloses a method of fabricating a semiconductor device, comprising the steps of: forming an SiC barrier film over an interconnection; forming an interlayer dielectric film containing Si, C, and O over the SiC barrier film, wherein the interlayer dielectric film is a low dielectric constant film; forming a hole reaching the SiC barrier film in the interlayer dielectric film; performing plasma processing on side surfaces of the interlayer dielectric film, the side surfaces being exposed to the hole, thereby inherently giving impact to the side surfaces of the interlayer dielectric film to harden the side surfaces with the interconnection being covered with the SiC barrier film; etching the SiC barrier film to allow the hole to reach the interconnection, after the plasma processing; and burying a conductive material in the hole, as shown above.

8. APA discloses [Re claims 17-19] wherein a film selected from the group consisting of a porous silica film, SiOC film, porous SiOC film, SiOCN film, and porous SiOCN film is formed as the interlayer dielectric film (see fig. 8A; paragraph 6).

9. APA discloses [Re claims 20-22] wherein a single damascene method is used, and the hole is formed as a wiring trench (see figs. 8A-8D; paragraphs 5-10).

10. [Re claims 23-25] Yamanaka also discloses wherein a dual damascene method is used, and the hole is formed as a wiring trench and as a via hole (see figs. 7A-7H; page 1, paragraph 10).

11. Claims 4, 6-7 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Yamanaka, as applied above, and further in view of Tonegawa et al. (US Pub. 2003/0155657; hereinafter "Tonegawa").

The combined teaching of APA and Yamanaka fails to disclose expressly [Re claim 4] wherein a gas containing at least  $\text{NH}_3$  gas is used as the hydrogen-containing gas; [Re claim 6] wherein a thickness of the side surfaces to be modified by the plasma processing is not more than 10 nm; [Re claim 7] wherein the plasma processing is performed by supplying a gas containing  $\text{N}_2$  gas and not substantially containing oxygen into a processing chamber in addition to the hydrogen-containing gas; [Re claim 13] wherein the plasma processing is performed by supplying a gas containing at least He gas into processing chamber.

Referring to figures 4A-13B, Tonegawa discloses a He/ $\text{H}_2$  plasma treatment (page 5, paragraphs 67-68). Besides He/ $\text{H}_2$ , a mixed  $\text{H}_2$  and a gas containing ammonia can be used (page 5, paragraph 68). Since ammonia gas can be used for the plasma treatment, the  $\text{N}_2$  gas is inherently presented into the processing chamber. And for He/ $\text{H}_2$  plasma treatment, Tonegawa does not disclose any oxygen gas presented in the processing chamber. The thickness of a modified layer 25 by the plasma treatment is shown in Table 5 (page 6, paragraphs 74-76). In the case where claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists. *In re Wertheim*, 541 F. 2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F. 2d 1575, 16 USPQ 2d 1934 (Fed. Cir. 1990).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use He/H<sub>2</sub> and ammonia plasma treatment, as taught by Tonegawa.

The motivation for doing so would have been to improve adhesion (page 3, paragraph 35).

12. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Yamanaka, as applied above, and further in view of Han et al. (US Pub. 2002/0164872; hereinafter "Han").

APA discloses wherein further comprising the step of forming an SiO<sub>2</sub> film 106 on the interlayer dielectric film, between the step of forming the interlayer dielectric film and the step of forming the hole in the interlayer dielectric film (paragraphs 5-10), wherein the hole is also formed in the SiO<sub>2</sub> film in the step of forming the hole in the interlayer dielectric film (see figs. 8B-8C). But it fails to disclose expressly wherein the plasma processing is performed such that no organic film is formed over the SiO<sub>2</sub> film.

Referring to figures 5-6, Han discloses an organic film, which is silicon-rich carbide (SRC) barrier layer 112, formed by a plasma enhanced chemical vapor deposition (PECVD) (page 3, paragraph 40). And as shown in figure 6, the barrier layer is formed only side surfaces of a dual damascene opening 102.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the method of forming an organic film, as taught by Han.

The motivation for doing so would have been to improve adhesion on side surfaces of a via hole (page 3, paragraph 47).



13. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over APA in view of Yamanaka, as applied above, and further in view of Joshi et al. (US Pub. 2006/0051968; hereinafter "Joshi").

Yamanaka discloses the plasma treatment using  $C_4F_8$  gas,  $C_3F_6$  gas,  $C_5F_8$  gas or  $CHF_3$  gas (page 7, paragraph 104). But it fails to disclose expressly wherein  $C_4F_6$  gas is used in the step of etching the SiC barrier film.

Joshi discloses an etching process to etch a substrate, which comprises oxides (page 3, paragraph 32), using a plasma based on a mixture of  $C_4F_6$  and  $C_2H_2F_4$  (page 2, paragraph 14).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the etching process, as taught by Joshi.

The motivation for doing so would have been to provide a process that exhibits excellent corner layer selectivity, photo resist selectivity, under layer selectivity, and profile and bottom CD control (see abstract).

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Cheung Lee whose telephone number is 571-272-5977. The examiner can normally be reached on Monday through Friday from 8:30AM to 5:00 PM.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on 571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Cheung Lee

May 9, 2006



**HA NGUYEN**  
**PRIMARY EXAMINER**